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SID 62-153

# PRELIMINARY FACILITIES PLAN FOR PROJECT APOLLO SPACECRAFT

PHASE A, SEGMENT 1
Contract NAS 9-150

[U]

4.5.3.1.2

26 January 1962

Approved by

J. W. Paup 1/31

J. W. Paup
Vice President and Apollo Program Manager



NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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# FOREWORD

Presentation of the North American Aviation Facility Plan, Phase A, Segment I of the Apollo spacecraft is in accordance with part 4 of Program Management paragraph 4.5.3.1.2 and is required by article I-A of contract NAS 9-150.

# CONTENTS

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# INTRODUCTION

This Preliminary Facilities Plan is an outline documentation of planned facilities required for the Apollo spacecraft program. This presentation will be implemented with an oral briefing. Charts, plot plans, and illustrations will be used to define existing and new areas. The facilities, resources, and capabilities of North American Aviation, Inc., will be used in performance of the Apollo program. The Space and Information Systems Division has at its disposal specialized facilities available in the other NAA operating divisions.

The facilities and capability of the subcontractors and associate contractors will be utilized to the maximum extent possible in accordance with the requirements of the program.

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# I. FACILITIES

## SUMMARY

The Space and Information Systems Division will centralize the Apollo program management, research, engineering, and manufacturing activities in its main plant in Downey, where environmentally controlled areas, laboratories, and support functions will be located. To assure teamwork, project management and engineering areas will be adjacent. The finest test facilities will be employed in the development and qualification testing of the spacecraft. In addition to North American's test facilities, it is proposed to make maximum practical use of government, subcontractor, and supplier test facilities with minimum modification.

## APOLLO FACILITIES SUMMARY

The Apollo spacecraft and its support equipment will be developed, designed, and manufactured by the Space and Information Systems Division of North American Aviation, Inc., at Air Force Plant No. 16, located just east of Los Angeles in Downey, California. This industrial complex, provided under Air Force facilities contract, AF 33(038)-9546, occupies 164 acres of land and has, at present, over 1.5 million square feet of covered floor space. This facility is readily accessible to land, sea, and air transportation. All buildings and outlying facilities are interconnected with concrete or blacktop roads, runways, and aprons for ease in movement of large spacecraft and weapons systems. A planned evacuation by the Autonetics Division from the Downey plant is now in progress, and relocation of certain support and service functions to nearby leased facilities is proceeding on schedule.

## APOLLO FACILITIES PLAN

The following plant facilities of North American Aviation will be involved in the overall development, fabrication, assembly, test, and checkout of the Apollo spacecraft program.

### Office and Design Areas

The Apollo project management office will be located in an area adjacent to the Apollo engineering operations offices and design areas. Office space will also be provided for the NASA representative and his staff, as well as representatives of major S&ID contractors.

[redacted]

Division Laboratories

S&ID's Space Science, Engineering Development, Life Sciences, and Information Systems Laboratories will expand to support the Apollo program requirements. Some laboratory functions will be relocated to permit expansion of adjacent laboratory areas. New facilities will be required to house some of the advanced and expanded laboratory functions. Maximum ulitization practicable will be made of existing laboratory facilities of North American. The Aerospace Laboratory and other NAA Divisions' highly specialized laboratory facilities will be utilized as required. North American's sonic testing facility at the Aerospace Laboratory in El Segundo, California is planned to be modified to produce pressure levels up to 190 db for Apollo testing. This acoustic chamber housing the world's largest catenary horn will provide simultaneously acoustical and mechanical vibration at elevated temperatures for Apollo development tests.

The division laboratories will provide testing services for research and development to advance the state of the art in prototype, design proof, qualification, reliability, and quality verification. Equipment and spacecraft systems in new and existing North American Aviation and government facilities will be subjected to simulated service environments: static and dynamic loads, transient temperatures, acoustics, acceleration, shock, salt spray, humidity, fungus, sand and dust, solar radiation, cold sink of space, and altitude. Division laboratories for conducting analytical and experimental studies on physiological processes, behavioral processes, bio-astronautics, etc., and for developing specialized hardware and techniques for life support, space systems, flight sciences, etc. will be provided. Division laboratories for conducting applied research and development in the fields of sensors and pattern recognition, and laboratories for developing displays to develop components for detection, tracking, data processing will also be provided.

Laboratory facilities will be required for Guidance and Navigation Engineering, and they will be used to evaluate components and subsystems of the Apollo guidance and navigation systems. The Laboratories will be use for design evaluation of all interface problems and equipment, for mechanical and functional compatibility checks, and for malfunction analysis. A stabilization and control systems laboratory to synthesize breadboard tests, to evaluate modulation schemes, to analyze tests, and to evaluate switch logic is required. This laboratory will be used for verification, trouble-shooting, bench baintenance; for evaluation of prototype GSE; and for development evaluation. An anechoic chamber and acoustic facilities are planned. A space system development laboratory is planned to house special vibration and shock equipment, hazardous tests cells for ultra-high temperatures, and pressurization systems.

[redacted]

Plans for the construction of a company-financed, hard-vacuum space chamber at North American Aerospace Laboratory are nearly complete. As soon as the facility is completed, it will be used to support the Apollo spacecraft program. Scheduled date of completion is September 1962. The stainless steel chamber will be 15 feet in diameter and 26 feet long, and it will be housed in a 50 by 60 foot building. Its ultimate vacuum pressure will be $1 \times 10^{-8}$ mm of mercury. Additional space environment equipment including a solar and thermal simulator is planned to be housed at this facility.

Electrical Power System Test Facility

A new facility for hazardous tests will be provided for electrical systems development tests. The test cell will be constructed for fire and pressure relief, and the necessary equipment will be incorporated as a part of the test cell. The facility will be approximately 2025 square feet. It will include a 500 square foot test cell flanked by two 200 square foot storage areas for gaseous oxygen and hydrogen, and liquid nitrogen. Explosion proof viewing ports will be installed in the protective wall between the test cell and the control room. Power requirements demand a 28 volt dc; a 100 volt, 60 cycle ac; and a 400 volt, 60 cycle ac with explosion proof electrical outlets.

Water Impact, Flotation, and Recovery Tests

From August 1962 though September 1963, a test site is required to complete land and water impact, recovery aids, water egress, flotation, and logistics recovery tests. The conduct of the water impact tests under conditions approximating expected water landing environments will require actual ocean testing. Preliminary investigation of local test facilities indicates the possibility of using the Naval test site at Point Mugu, California for conducting these tests. At least one of the test sequences will consist of monitoring post-landing recovery and performance of survival aids and checking vehicle seaworthiness for 7 days.

Computer and Simulation Facility

Although S&ID's computer facility is well-balanced from an operational and environmental standpoint an IBM 7090 digital computer and five additional sections of an Analog computer will be provided on the site until a planned simulation and information processing center is completed.

Prior to the completion of this new facility, an area will be allocated next to the existing computer facility to allow Analog computer tie-in with the semi-hard mockup and with the life science mockup. These computers and simulators will be relocated to the new simulation and information processing center which will also have the following additional simulation

[redacted]

facilities. Two engineering simulators of Apollo command modules will be provided for mission simulation including rendezvous, earth and lunar orbit, lunar landing, etc. A planetarium, visual simulation laboratory, observation room, environmental chamber, attitude control simulator, navigational aids area, aero ground equipment area, flight table area, fabrication calibration area, an attitude and control systems test cell, and a control center area will be provided to support the total mission simulation studies.

Data Ground Station

A new PCM/PAM data acquisition and processing system will be installed in Building No. 6 adjacent to the Final Assembly and Systems Integration Facility. The ground station and computer-plotter area will be noise controlled and will have a raised floor for cable distribution and for installation of air conditioning plenum chambers. An observation area will be provided for display of realtime data. The adjacent area will be provided for data review and storage rooms, projection and dark rooms, spare parts and raw material storage, and offices. The building modification for the new ground station will include the installation of the raised floor; air conditioning for clean, temperature, and humidity controlled air; acoustic walls and ceilings for noise control; and regulated and unregulated power.

Subassembly, Assembly, and Mockup

Approximately 19 mockups of various configurations for engineering evaluation will be fabricated in the high-bay manufacturing area. The mockups will be used to evaluate physical size and space provisions of each design objective.

A separate area will be provided for mockups after fabrication for design engineering evaluation review. Mockups will be up-dated to reflect the latest engineering changes and concepts.

The mockup area will be equipped with modern shop equipment and facilities required to build and maintain mockups of wood, fiberglass, and metal.

Fabrication and refurbishment of the boilerplate and prototype command modules, service modules, spacecraft adapters, and launch escape tower systems will be accomplished in the high-bay manufacturing area of Building No. 1 under an existing 14,000-pound bridge crane system. This will permit the utilization of existing facilities and equipment.

[redacted]

## Boilerplate Final Assembly and Checkout

Bench maintenance, boilerplate subsystems assembly, boilerplate final assembly, and checkout operations will be initially performed in Building No. 1. The bench maintenance operation will be located in an existing clean temperature-controlled area adjacent to the manufacturing high-bay. Systems verification tests will be conducted in this area. This operation will be relocated adjacent to the manufacturing final assembly area when the addition to Building No. 6 is completed.

Subsystems assembly operations will be conducted in the adjacent low-bay area. Mechanical and electrical subsystems will be assembled in this area prior to installing them in the boilerplate modules.

The installations of subsystems and components will be accomplished in an existing high-bay manufacturing area. Bridge cranes to support this operation are available.

The mating of the modules and escape tower, the checkout of the various systems, and the checkout of the instrumentation are planned to be accomplished by using the existing hydrostatic test tower. This 110 foot tower is equipped with a bridge crane capable of handling the modules. Power and equipment will be provided to checkout the subsystems and instrumentation for this operation.

## Electrical and Electronic Assembly, Tubing, and GSE

Electrical and electronic assembly, tubing and GSE fabrication are planned to be accomplished at the Slauson Facility, a locally leased facility.

The function of this area will be to assemble electronic modules and electrical wire assemblies. This includes all soldering harness jigging, module and black box assembling, functional checkout, and environmental checkout.

Fabrication of GSE includes the fabrication of consoles (welding, riveting, and metal fitting), the assembly of electrical and mechanical modules which become a part of the consoles, the functional checkout of these modules, and the installation of modules into the consoles. The complete functional GSE includes slings, dollies, transporters, check fixtures, adapters, and specific packaging items.

Fabricating tubing includes such operations as cutting, bending, flaring, welding, and cleaning.

[redacted]

This facility will have electronic, hydraulic, and pneumatic calibration equipment and environmentally controlled areas to comply with design specifications.

## Training Equipment

It is planned that Apollo training equipment will be fabricated and checked out in the manufacturing areas in Building No. 1. Both 20-and 35-foot bay height areas will be required for equipment installation, mating, and checkout.

Subassembly and checkout of electrical, pneumatic, and hydraulic systems will be accomplished in clean enclosed areas to preclude contamination of systems. Fabrication of trainer structures will be accomplished with the newest types of equipment and facilities available to maintain the lowest costs possible and to maintain quality assurance.

Final assembly and checkout will be performed in a high-bay area with bridge crane coverage for mating operations and material handling. Special power requirements compatible with design specifications for trainer operations and checkout will be provided.

It is planned to provide space in Building No. 3 for training operations, which will include training classrooms and an area to house maintenance trainers with associated ground support equipment.

## Bonding and Test Facility

A new building will be constructed to house the Apollo bonding and test operations. This new 23, 400-square-foot building will consist of structural steel framing with insulated corrugated metal siding and a reinforced concrete floor. Bridge crane coverage will be provided. This building will be 100 by 180 by 50 feet and will have an adjacent office and support area, 30 by 180 by 24 feet. This facility will be used for cleaning the aluminum honeycomb and facing sheets, prebond priming, preparation of honeycomb and adhesives prior to bonding, layup of honeycomb panels, bonding, and

ultrasonic inspection of the bond. An area will also be included for hydrostatic and helium leak checking the command modules. The bonding area will be temperature and humidity controlled and will contain autoclaves and adequate refrigeration for storing adhesives.

Radiographic Facility

The existing 1920-square-foot X-ray facility will require a 1920-square-foot addition to support the Apollo radiographic inspection requirements. This addition will be a 24- by 80-foot corrugated metal building with a 15- by 15-foot sliding door at each end. All four walls will be lead-lined from the floor to a 10-foot height, and will conform to AEC Handbook 60. This expanded facility will be utilized for all radiographic inspection for production fusion welds, purchased electrical and electronic components, and assemblies and will also be utilized by Materials Review for Evaluation of suspect areas or items. Complete X-ray film processing, evaluation, and storage capabilities are part of this facility and will be employed for Apollo support.

Systems Integration and Checkout Facility

The planned facilities for supporting the flight acceptance, and systems integration, and manufacturing final assembly activities will be combined into a new addition to Building No. 6, USAF Plant No. 16.

Manufacturing Final Assembly Area

The final assembly operation will consist of components and systems installation in the command modules, the service modules, and the space adapters. Functional checkout of components and systems on an individual basis will be conducted as required. The installation and operations will be conducted in an environmentally controlled area as required by applicable specifications.

Subsystems assembly will consist of manufacturing assembly operations, such as components and subsystems which require a controlled environment. This operation will be located to provide transfer of assemblies directly into final assembly. Air showers and clean rooms will prevent component and systems degradation.

Combined systems checkout will be conducted upon completion of the individual modules in an environmentally controlled area. This area will contain equipment for conducting simulated flight attitudes.

Systems integration will be conducted in an area adjacent to combined systems checkout operations. This operation will include mating of the individual modules. All mating and breakaway points will be checked, and electro-mechanical continuity will be established. This area will also be environmentally controlled.

Systems verification tests will be conducted in the bench maintenance area to determine the extent of the rework required on systems or components (vendor and GFAE), which have been removed from the modules for maintenance operations. This area will contain environmentally controlled areas for systems checkout. Areas to house vendor representatives will be provided.

The control rooms, which will house test equipment complexes for the checkout operations, will be adjacent to the specified operational areas. These rooms will be temperature and humidity controlled.

A calibration room will be provided for calibrating test equipment to be used in support of final assembly, combined systems checkout, and integrated systems checkout. A stockroom will be provided to house all components and systems required for final assembly and checkout. Air showers will be placed adjacent to this room to inhibit or prevent degradation to the environmentally controlled rooms.

Flight Acceptance and Systems Integration Area

The planned location of this area and will be adjacent to the manufacturing final assembly area, will permit minimum handling of the modules under controlled environment and maximum utilization of the high-bay area. Adjacent support areas will be dust and temperature-humidity controlled to eliminate possible contamination. Air locks will be provided at all entrances and exits to controlled areas.

Control rooms will be located to provide visual check as well as data monitoring of instrumentation calibration and checkout and combined systems check. Electronic laboratories and shielded areas will be designed and located for maximum utilization and radiation control.

A separate area will be provided to handle liquid and gaseous transfer equipment. Hazardous storage will be provided in a remote area.

Propulsion Systems Development Facility

This facility is to be located in an existing area at North American's Solid Propulsion Plant at McGregor, Texas (USAF Plant No. 66). The test area is planned so that testing operations will neither jeopardize nor

interfere (nor be subject to interference) with the Apollo program or the other programs. Major facility requirements are described in the following paragraphs.

Test Stand

A new structure will be constructed to support the Apollo spacecraft and/or systems during the various tests. Facilities will be provided to support complete systems compatibility testing under hot-firing conditions. Provisions will be made to contain the escape tower following jettisoning from the spacecraft during development tests. An umbilical boom will be installed to service the spacecraft and provide umbilical connections to simulate launch conditions. A bridge crane will be provided to position the spacecraft with a hoist to place the escape tower. A terminal room will be constructed at the stand to provide for short-run cables connecting the long-run cables from the control center to the spacecraft. An adapter will be installed over the flame bucket to support the spacecraft and thrust measuring devices will be added to measure engine reaction and thrust. The stand will permit full engine gimbaling. An air lock chamber will be installed on the bridge crane to provide crew access to the command module. An emergency exit will be positioned by the escape hatch in case of danger. A ground control station will be constructed to house the propellant transfer units that will be used to check out the spacecraft propulsion systems prior to static firing tests. A Firex system will be installed to protect the spacecraft and stand from damage resulting from spillage, fire, and explosions.

Control and Instrumentation Center

A new building will be constructed for test conduction and data acquisition equipment and activities. Room will be provided for 20 two-bay consoles. A closed-circuit television system for observation of the test stand during actual firing will be installed. Provisions will be made for recording equipment to handle approximately 500 measurements from external power on the spacecraft during the test runs. This building will be air conditioned to provide for proper operation of equipment and personnel.

Service Building

A new 22,000-square-foot general purpose building will be constructed to provide facilities for spacecraft and ground support equipment preparation and maintenance and office space for personnel. It will be located at a safe distance from the stand and will be provided with separate areas for the following:

[redacted]

1. Servicing of instruments and controls from the spacecraft and control center and the preparation of special instrumentation set-ups for measurements of temperature, pressure, electrical, vibration, and acoustics from external points on the spacecraft.

2. Systems preparation, which will allow assembly, checkout, or rework of the existing systems or components prior to installation or after removal from the spacecraft. These will include mechanical, fluid, and propulsion systems; or electrical, electronic, and instrumentation components.

3. Ground support equipment storage, servicing and repair. This includes supporting tool crib, parts storage, and meter room.

4. Environmentally controlled area to house the spacecraft during major modification, instrumentation, and modification of the spacecraft. A high-bay area is required for this operation.

5. Necessary utilities, conditioned areas, and building facilities required for the operations involved.

6. Office space for test personnel.

Liquid and Gas Storage and Transfer

Facilities will be installed to store and transfer all liquid and gas propellants, pressurants, fuels, and refrigerants for the usage required with the necessary transfer equipment for loading the spacecraft. Adequate protection will be provided for both personnel and equipment at the transfer points.

Solid-Engine and Igniter Storage

A facility will be provided at a safe distance from the complex for the storage of solid engines, solid propellants, and igniters. This facility will be in accordance with the presently accepted criteria for this type of storage and will include the necessary safety considerations.

Facilities

The necessary roads, grading, embankments, water, sewage, and electrical services will be provided for this test facility. Standard safety considerations will be followed.

# II. TEST AND RANGE FACILITIES

Successful development of the Apollo spacecraft depends upon accurate knowledge which is gained from data that have been obtained through well-managed test programs. The test facilities presently available at NAA, vendors, suppliers, and subcontractors will be utilized to the fullest extent during the development test program. These facilities will be augmented, where necessary, by existing government facilities and by new test facilities.

## AERO-THERMODYNAMIC TESTING

A highly concentrated, three-phase, aero-thermodynamic test program is proposed for the Apollo spacecraft design and development as follows:

1. Preliminary Design Data. Parametric studies on small models in readily accessible wind tunnels.

2. Design Evaluation. Data taken with larger models at Reynolds numbers more closely approaching flight conditions.

3. Design Problem Investigations. Tests to be conducted to study detail problems discovered during 1. and 2.

The recommended wind tunnel facilities required to accomplish this program are listed in Table 1.

## PROPULSION SYSTEM DEVELOPMENT

An altitude-simulation firing facility is required for propulsion systems development and proof-test hot firing tests. The present plan is to use the new AEDCJ-4 altitude test cell, which is scheduled for completion in early 1963. The complete spacecraft, including the launch escape system, will be tested in the chamber under firing conditions using flight nozzles. The chamber is approximately 90 feet in diameter and 200 feet in length. The basic facility elements required for the spacecraft testing will be similar to the sea-level facility with the following two exceptions:

1. Tethered launch escape system testing will not be performed.

[redacted]

## Table 1. Recommended Wind Tunnel Test Facilities

| Facility | Abbreviation | Mach Range | Stag. Press (psia) | Stag. Temp (°F) | Re/Ft by $15^6$ | Type | Test Section |
|---|---|---|---|---|---|---|---|
| North American Aerodynamics Laboratory | NAAL | Subsonic | 15 | 70 | 1.9 | Continuous | 8 ft. by 11 ft. |
| North American Aviation, Supersonic Aerophysics Laboratory | SAL | 0.7, 1.6-3.25 | 15 | 70 | 2-4.6 | Blowdown | 16 in. by 16 in. |
| North American Aviation, Trisonic Wind Tunnel | TWT | 0.2-3.5 | 15-110 | 70 | 5-14 | Blowdown | 7 ft. by 7 ft. |
| Jet Propulsion Laboratory 20 in. Supersonic | JPL 20 in. | 1.3-5 | 2-60 | 110 | 0.4-6 | Continuous | 20 in. by 20 in. |
| Jet Propulsion Laboratory 21 in. Hypersonic | JPL 21 in. | 5-9.5 | 20-600 | 100-1200 | 0.25-3.6 | Continuous | 21 in. Diameter |
| Langley 8-ft. Transonic Tunnel | LTPT | 0.25-1.2 | 5-15 | 125 | 0.6-2.5 | Continuous | 8 ft. by 8 ft. |
| Langley Unitary Plan Wind Tunnel | LUPWT | 1.4-5 | 30-55 | 150 | 5-11 | Continuous | 4 ft. by 4 ft. |
| Ames Unitary Plan Wind Tunnel | AUP | 0.7-3.5 | 29-35 | 120 | 3-9 | Continuous | 11 ft. by 11 ft., 9 ft. by 7 ft., 8 ft. by 7 ft. |
| Ames Prototype Hypersonic Free Flight Facility | ABR | 30,000 FPS | | | | Free flight | 0.45 in. Diameter Model |
| Ames 6 in. Arc Jet | A6 in. AJ | 12, 14 | | 900 BTU/LB | | Continuous | 6 in. Diameter |
| AEDC Tunnel A-40 | AEDC A | 1.5-6 | 1-200 | 70-310 | 0.3-9.5 | Continuous | 40 in. by 40 in. |
| AEDC Tunnel B-50 | AEDC B | 8 | 100-800 | 900 | 0.4-3.3 | Continuous | 50 in. Diameter |
| AEDC Tunnel C-50 | AEDC C | 10, 12 | 175-2400 | 1500 | 0.3-3.1 | Continuous | 50 in. Diameter |
| Arnold Engineering Development Center Hotshot II | AEDC HSII | 16-21 | 16,100 | 5400 | 0.21-.55 | Impulse | 50 in. Diameter |
| Ballistic Research Laboratory Transonic Range | BRL T | 0.5-2.0 | | | 0.5-1.0 | Free flight | 6 in. Diameter Model |
| Cornell Aeronautical Laboratory Shock Tunnel | CAL ST | 6-20 | | | 0.002-28 | Impulse | 24 in. Diameter |
| Lewis 10 ft. by 10 ft. | L10 ft. by 10 ft. | 2-3.5 | 14-.35 | 120-330 | 2.2-3.2 | Continuous | 10 ft. by 10 ft. |
| Lewis 8 ft. by 6 ft. | L 8 ft. by 6 ft. | 0.7-2.2 | 15.6-25 | 138-200 | 4.2-4.8 | Continuous | 8 ft. by 6 ft. |



[redacted]

2. Crew-loading capsule environment will not be required.

The AEDC facility is an Air Force facility; therefore, coordination through Apollo program channels will be required.

WALLOPS ISLAND

The purpose of the Little Joe I flight test is to evaluate the early mission abort system or launch escape system. These tests will be conducted by the contractor in two general categories: the first at the end of booster burnout and the second at maximum dynamic pressure conditions. These tests will be conducted at the NASA test facility at Wallops Island, Virginia, during the first quarter of 1963. White Sands Missile Range (WSMR) or Edwards test facility are possible alternate sites. A minimum of two Little Joe test vehicles, equipped with boilerplate command modules, will be tested during this phase. Office space, maintenance area, checkout area, and launch complex are required to support these tests.

ATLANTIC MISSILE RANGE

Preparation and checkout operations on the spacecraft are divided into the following six general categories:

Receiving inspection and preparation for checkout
Functional checkout (individual systems horizontally mated)
Altitude chamber checks
Static firing
Simulated countdown and launch for integrated systems (vertically mated)
Launch pad operations

These requirements plus the service areas are shown in Table 2.

Preparation for Checkout

The modules will first enter the receiving inspection and preparation area for checkout. A receiving inspection and configuration review, down to the subsystem module level, will be performed in this area. Ground support equipment will also undergo similar checks. A clear "white-room" area is required for this operation.

Functional Checkout

Functional checkout operations will require horizontal mating or interconnecting of the spacecraft modules, and ground support equipment

Table 2. AMR Facility Requirements

| Facilities | Area (sq ft) | Remarks |
|---|---|---|
| Office area | 30,000 | Includes space for associate contractors |
| Mechanical laboratory | 1,500 | |
| Mechanical shop | 7,000 | |
| Propulsion maintenance | 1,600 | |
| Tool and supply room | 2,300 | |
| Electrical laboratory | 1,000 | |
| Electronics laboratory | 6,800 | |
| Calibration laboratory | 900 | |
| Material laboratory | 1,000 | |
| Navigation and guidance laboratory | 2,800 | |
| Stabilization control laboratory | 1,000 | |
| Communications laboratory | 1,000 | |
| Spares control | 3,800 | |
| Ground recording | 2,000 | |
| Data processing | 1,500 | |
| Quick look | 1,000 | |
| Data review | 2,100 | |
| Receiving inspection area | 7,000 | |
| Modification area | 10,000 | |
| Horizontal checkout area | 10,000 | |
| Vertical checkout area | 19,000 | Two altitude chambers/control areas<br>Two vibration stations |
| Control rooms (4) | 6,000 | |
| Power room | 1,000 | Isolated power to each major checkout area |
| Locker room | 1,230 | Facilities for 100 technicians |
| TWX-FAX room | 1,250 | |
| Photographic laboratory | 1,000 | |
| Reproduction | 1,300 | |

Table 2. AMR Facility Requirements (Cont'd)

| Facilities | Area (sq ft) | Remarks |
|---|---|---|
| Print files | 1,000 | |
| Library | 900 | |
| Hazardous work area | 300 | With emergency facilities such as deluge, showers, etc. |
| GSE storage | 20,000 | |
| GSE maintenance shops | | |
| GSE Maintenance wood | | |
| GSE Maintenance metal | 3,500 | |
| GSE Maintenance paint | | |
| Office | 1,000 | |
| Warehouse | 30,000 | |
| Shipping and receiving | 3,500 | |

required for service, command, and system analysis. A clear area with white-room specifications is required for this area. Approximately 10,000 square feet will be required for functional checkout.

Altitude Chamber Checks

The spacecraft will undergo a series of checks in an altitude chamber to verify the hermetic property of the command module before and after static-firing. Two altitude-chambers with control areas and vibration stations will be required.

Static Firing

After the altitude chamber checks have been completed, the spacecraft will be moved to the static firing area. A test stand will be required for the vertical mated module firing. Storage will be required for propellants, cryogenics, gas, etc. A control room will be required with the capability to run firings from the control room or the command module.

Simulated Countdown

Following static firing and altitude chamber checks, the spacecraft is moved to the vertical checkout facility. The test configuration will consist of an S-I simulator, an S-IV simulator, the adapter, service module, command module, and escape tower. A simulated countdown will be performed and will be followed by a simulated flight.

Launch Pad Operations

Contractor requirements at the launch site includes space in the control center for ground support equipment peculiar to the operation for the spacecraft, and provisions on the gantry and umbilical towers for the handling and servicing functions.

## GROUND OPERATION SUPPORT SYSTEMS

Ground operation support systems will provide support to Apollo flight operations by predicting and monitoring vehicle trajectories from launch to recovery, by monitoring crew status and vehicle systems performance, by maintaining the vehicle-earth communication and data links, and by maintaining a centralized control of the GOSS stations.

GOSS stations will be located and equipped to provide maximum contact with manned orbital flights, tracking and communications during injection

[redacted]

and reentry. The stations at the primary recovery sites will be prepared for landing and recovery operations for a three-orbit flight. Alternate sites will be prepared for one- or two-orbit flights.

GOSS performance and equipment requirements will be specified to NASA by S&ID and implemented by a NASA subcontractor.